Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_

**Gibbs Free Energy Practice**

AP Biology, Ms. Ottolini

|  |  |  |
| --- | --- | --- |
| **General rule** | **Endergonic** | **Exergonic** |
| Energy input or energy released? |  |  |
| Greater energy in the reactants or products? |  |  |
| Anabolic or catabolic? |  |  |
| High energy bonds formed, or broken? |  |  |
| Increasing complexity or decreasing complexity from reactants to products? |  |  |
| Entropy increased or decreased? |  |  |
| Change in G positive or negative? |  |  |
| Spontaneous or non-spontaneous? |  |  |
| Dehydration or hydrolysis? |  |  |
| Photosynthesis or respiration? |  |  |
| ATP formed, or ADP + P? |  |  |

**Notes on Gibbs Free Energy:**

• Enthalpy is expressed in kJ (kilojoules)/mol, entropy in J/K (joules/kelvin), and temperature in K. If you convert the entropy from J/K to kJ/K by dividing by 1000, your units will cancel in the Gibbs equation to give you a ΔG value in kJ/mol.

• Unless told otherwise, use the standard temperature of 298K (25C) when calculating Gibbs free energy.

• Free energy is calculated using Δ G = Δ H - T ( Δ S) where a negative G value is exergonic (spontaneous) and a positive is endergonic (non-spontanteous)

**• Practice Problems:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Rxn* | *Δ enthalpy (kJ/mol)* | *Δ entropy (J/K)* | *Δ Free energy (kJ/mol)* | *Ender- or exergonic?*  *Spontaneous or not?* |
| A + B -> AB | +12 | -5 |  |  |
| CD -> C + D | -32 | +25 |  |  |
| CH4 + 2O2 -> CO2 + 2H2O | -890 | -243 |  |  |
| *Rxn* | *Δ enthalpy (kJ/mol)* | *Δ entropy (J/K)* | *Δ Free energy (kJ/mol)* | *Ender- or exergonic?*  *Spontaneous or not?* |
| N2 + 3H2 -> 2NH3 | -92 | -199 |  |  |
| Hydrolysing ATP ->  ADP + Pi | - | - | -0.31 |  |
| Phosphorylation of Glucose (glucose + Pi) | - | - | +14 |  |
| \* 2COCl2 + H2O ->  CO2 + 2HCl | -223 | +284 |  |  |

\* Phosgene, COCl2, was used as a weaponized gas during World War I. It reacts with moisture in the lungs to produce HCl, which causes the lungs to fill with fluid, leading to death. Use the energy values above, at a **body temp of 37C (310K)** to see if this reaction is spontaneous or not.